Electronic Version
Stylesheet Version v1.1.1

Claims

[c1] 1. A fuel injection system for an internal combustion engine comprising a nozzle (2) with an inlet; a cam-driven plunger (5) forming a plunger chamber (7) said plunger chamber connected to the inlet of the nozzle; a common rail (10) for fuel; a control valve (9)between the plunger chamber (7) and the common rail (10), said control valve being able to open or close hydraulic communication between the plunger chamber and the common rail upon receiving an electrical control command; an electrically operated nozzle control valve (3) for opening and closing of the nozzle (2); a means (11) for pressurizing the common rail and regulating pressure of the fuel in the common rail (10); and a fuel tank (13).

[c2] 2. The fuel injection system as recited in claim 1, wherein a non-return valve (20) is installed between said plunger chamber (7) and the common rail (10), with the inlet of said non-return valve connected to the common rail.

[c3] 3. The fuel injection system as recited in claim 1, wherein said control valve (9) isolates said plunger chamber (7) from the common rail (10) and connects the

plunger chamber (7) to the return line (12) while in a third position; isolates the plunger chamber (7) from both the return line (12) and the common rail (10) while in a second position; isolates the plunger chamber (7) from the return line (12) and connects the plunger chamber (7) to the common rail (10) while in a first position.

[c4] 4. A fuel injection system comprising a nozzle (2) with an inlet and a needle (15); a resilient means (14) biasing the needle to close the nozzle; a control piston (16) forming a control chamber (17) with an input throttle (18) and an outlet port (19), said control piston abutting the needle (15) such that an higher pressure in the control chamber (17) tends to urge the control piston (16) onto the needle to close to the nozzle; a cam-driven plunger (5) forming a plunger chamber (7), said plunger chamber connected to the input throttle (18) and the inlet of the nozzle (2); a common rail (10) for fuel; a control valve (9) installed between the plunger chamber (7) and the common rail (10), said control valve (9) being able to open or close hydraulic communication between the plunger chamber and the common rail upon receiving an electrical control command; a nozzle control valve (NCV) (3) installed between the outlet port (19) of the control chamber (17) and a return line (12), said NCV be-

ing able to open or close hydraulic communication between the outlet port (17) and the return line (12); a means (11) for pressurizing the common rail and regulating pressure of the fuel in the common rail; a fuel tank (13); said fuel injection system characterized in that the effective flow areas of said input throttle (18), outlet port (19) and the NCV (3) and the force of the resilient means (14) are chosen such that an opening of the NCV can cause the needle (15) to open the nozzle when the pressure at the inlet of the nozzle is below a maximum working pressure of the common rail.

[c5] 5. The fuel injection system as recited in claim 4, wherein a non-return valve (20) is installed between said plunger chamber (7) and the common rail (10), with the inlet of said non-return valve connected to the common rail.

[c6] 6. The fuel injection system as recited in claim 4, wherein said control valve (9) isolates said plunger chamber (7) from the common rail (10) and connects the plunger chamber (7) to the return line (12) while in a third position; isolates the plunger chamber (7) from both the return line (12) and the common rail (10) while in a second position; isolates the plunger chamber (7) from the return line (12) and connects 15 the plunger chamber (7) to the common rail (10) while in a first posi-

tion.

[c7] 7. The fuel injection system as recited in claim 4, wherein said input throttle (18) is connected to the common rail (10) instead of being connected to the plunger chamber (7).

[c8] 8. The fuel injection system as recited in claim 4, wherein said outlet port (19) and the control piston (16) are designed such that the control piston (16) is able to restrict the flow area of the outlet port (19) at a position corresponding to an open nozzle (2), thereby limiting the leakage of pressurized fuel through the input throttle (18), output port (19) and open NCV (3) to the return line (12).

[c9] 9. A fuel injection system comprising a nozzle (2) with an inlet and a needle (15); a resilient means (14) biasing the needle (15) to close the nozzle (2); a control piston (16) forming a control chamber (17) and abutting the needle (15) such that an higher pressure in the control chamber (17) tends to urge the control piston (16) onto the needle (15) to close the nozzle (2); a cam-driven plunger (5) forming a plunger chamber (7), said plunger chamber connected to the inlet of the nozzle (2); a common rail (10) for fuel; a control valve (9) installed between the plunger chamber (7) and the common rail (10),

said control valve being able to open or close hydraulic communication between the plunger chamber and the common rail upon receiving an electrical control command; a nozzle control valve (NCV) (3), said NCV being able to isolate said control chamber (17) from a return line (12) and open hydraulic communication between said plunger chamber (7) and the control chamber (17) while in a first position and being able to isolate the control chamber (17) from the plunger chamber (7) and hydraulically connect the control chamber (17) to the return line (12) while in a second position; a means for pressurizing the common rail (10) and regulating pressure of the fuel in the common rail; a fuel tank (13); said fuel injection system characterized in that the pressure in the common rail (10) can be set sufficiently high to overcome the force of the resilient means (14) and open the nozzle (2) when the NCV (3) is in its second position.

[c10] 10. The fuel injection system as recited in claim 9, wherein a non-return valve (20) is installed between said plunger chamber (7) and the common rail (10), with the inlet of said non-return valve connected to the common rail.

[c11] 11. The fuel injection system as recited in claim 9, wherein said control valve (9) isolates said plunger chamber (7) from the common rail (10) and connects the

plunger chamber (7) to the return line (12) while in a third position; isolates the plunger chamber (7) from both the return line (12) and the common rail (10) while in a second position; isolates the plunger chamber (7) from the return line (12) and connects the plunger chamber (7) to the common rail (10) while in a first position.

[c12] 12. The fuel injection system as recited in claim 9, wherein said NCV (3) isolates said control chamber (17) from the return line (12) and opens hydraulic communication between said control chamber (17) and the common rail (10) while in the first position; and isolates the control chamber (17) from the common rail (10) and hydraulically connects the control chamber (17) to the return line (12) while in the second position.

[c13] 13. The fuel injection system as recited in claim 1, wherein the means (11) for pressurizing the common rail (10) comprise an hydraulic pump of a variable displacement type and a means for controlling the displacement of said pump to achieve desired pressure in the common rail.

[c14] 14. The fuel injection system as recited in claim 1, wherein the means for pressurizing the common rail (10) comprise an hydraulic pump of a fixed displacement

type and a means for controlling the rotational speed of said pump to achieve desired pressure in the common rail.

[c15] 15. The fuel injection system as recited in claim 14, wherein said hydraulic pump is driven by the starter motor of the engine.

[c16] 16. The fuel injection system as recited in claim 1, wherein the pressure in the common rail (10) can be set to a maximum value of 600 bar.